"The Southern Cross"

HERMANUS ASTRONOMY CENTRE NEWSLETTER

NOVEMBER 2019

Monthly meeting This month's meeting will take place on **Monday 18 November** at the **Catholic Church Hall** starting at **19.00.** Centre member, Jenny Morris, will be talking on 'The Cassini dynasty and its Saturnian legacy' See below for more details.

Membership renewal for 2020

There will be no increase in fees next year.

The 2020 fees remain at:

Member: R160

Member's spouse/partner/child, student: R80

New members joining after 1 October 2018 will have membership until the end of 2019.

Payment can be made in cash (at meetings directly to the Treasurer), or via online transfer. The Standard Bank details, for the latter, are as follows:

Account name – Hermanus Astronomy Centre

Account number – 185 562 531

Branch code – 051001

If you make an online donation, please reference your name and 'subs' or 'membership', or it is not possible to attribute the payment to you.

2020 meeting dates For your diaries. Meeting dates will be: 20 January, 17 February, 16 March, 20 April, 18 May, 15 June, 20 July, 17 August, 21 September, 19 October and 16 November.

WHAT'S UP?

Transit of Mercury A transit is the passage of one object across another with an actual or apparent larger diameter. Transits of Mercury and Venus across the Sun are well-known examples. These planets only transit when they are in 'inferior conjunction' ie when they are positioned between the Earth and the Sun. In superior conjunction, they are in a direct line with, but behind the Sun. Transits of Mercury are more common than those of Venus. While Around thirteen of the former occur every century, the latter occur in a 243 year cycle. On **11 November**, Mercury will transit the Sun from 14.35 – 20.04. **NB Do not look directly at the Sun.** View the transit indirectly eg project sunlight onto a sheet of white paper via binoculars and observe the small circular shadow's movement taking place on the paper..The next transit of Mercury will take place on 13 November 2032.

The last transit of Venus occurred in 2012, the next one will take place far into the future, in December 2117.

LAST MONTH'S ACTIVITIES

Monthly centre meeting The presenter at the 21 October meeting was Dr Nicolas Erasmus, Instrumentation scientist at the SAAO in Cape Town. His informative and absorbing talk was on 'Near-Earth asteroids: vermin of the night sky". Nic stated that, of the other 800,000 asteroids discovered (mostly in the asteroid belt between Mars and Jupiter), around 21,000 are near-Earth objects (NEOs). These have been moved from their orbits, mostly by the effect of Jupiter's presence. Although, increasingly small, increasing numbers of asteroids are being discovered daily, largely due to dedicated discovery programs like ATLAS. Once a new asteroid has been confirmed by the Minor Planet Centre during a careful process of checks and repeated observations of its orbit and magnitude (brightness), astronomers, like Nic, then investigate them in order to identify their other characteristics. These include colour (revealing what material they are made of), shape, size and rotation period. This challenging process may require mathematical means to separate out informative data from the light curves and spectra.

Finally, Nic looked at the level of threat which NEOs can have for Earth. Overall, people need not be too concerned. It is the larger objects which pose the greatest threat, and these, because of their size, are known, although, like other asteroids, external forces can change their orbits. However, close ongoing monitoring of NEOs means that this would be quickly noted. Numerous ways of deflecting an incoming asteroid continue to be considered and, as long as we have enough time, it is likely that we will be able to save Earth from impact.

Interest groups

Cosmology At the meeting on 7 October, Derek Duckitt presented the second of a two-part DVD series on Loop quantum gravity''. In part 3, Carlo Rovelli talked about 'Loop quantum gravity' and, in part 4, 'Searching for white holes'.

Astro-photography At the 14 October meeting. Members discussed images they took at the recent Southern Star Party.

Other activities

Educational outreach

Hawston Secondary School Space Cadets The last meeting of the year took place in October.

Lukhanyo Youth Club Construction of the analemmatic sundial at Lukhanyo is complete, Work continues on others at other Overstrand schools.

Stargazing Unfortunately, adverse weather conditions led to cancellation of the events planned for both 5 and 25 October.

Science workshop On 24 October, Pierre de Villiers led a workshop, at SANSA, for 13 educators and 16 learners from four schools on the topic of the Solar System. Like earlier workshops, this aimed to enrich teaching and learning in the 'Earth and beyond' part of the school curriculum.

Cape Town visit On 26 October, ten Centre members and some family members spent a very enjoyable day visiting several sites of astronomical interest in Cape Town. First, they experienced the very loud, but exciting event of the Noon gun, Cape Town's oldest

living tradition. Then, following lunch under the trees at the restaurant in the Gardens, they attended a show at the Iziko Planetarium. The main film was 'Journey to the stars'. This was followed by a fascinating guided tour of the South African Astronomical Observatory, which included a number of places and items we have not seen on earlier visits. After supper at the neighbouring River Club, they attended the SAAO fortnightly lecture. Prof Mario Santos from UWC talked on 'My job as a cosmologist'.

Southern Star Party Derek Duckitt, Peter Harvey and Benni Kotze attended the 26-29 September event, which was held at Leeuwenboschfontein. Their report, including several images, will be sent out separately with the newsletter.

Whale Talk article An article by Jenny Morris titled 'Feeling the heat: investigating the Sun' was published in the September-November issue of the magazine.

THIS MONTH'S ACTIVITIES

Monthly centre meeting This month's meeting, will take place on **Monday 18 November** in the **Catholic Hall** starting **19.00**. Centre member, Jenny Morris will be talking on 'The Cassini dynasty and its Saturnian legacy' She states :Across a span of more than three centuries, two important periods in astronomy are linked by one solar system object: planet Saturn. During the later 1600s, the Italian astronomer Giovanni Cassini and Dutch telescope builder Christiaan Huygens discovered several structures in the area surrounding Saturn, including moons and gaps in the ring system. Cassini was the patriarch of four generations of Cassini astronomers and cartographers who made important contributions to both these disciplines at a time when science was advancing rapidly.

Over 300 years later, the contributions of both Cassini and Huygens were recognised in the naming of the orbiter and lander of an extraordinarily successful space mission. The 1990s technology, used for over a decade in the Cassini-Huygens mission, discovered and described a myriad of novel objects and breathtaking features of Saturn and its moons and rings which have advanced, and will continue to expand and challenge, our understanding of Saturn and the solar system, for years to come.

In this presentation, I shall look back over the lives, times and achievements of the Cassini family, then move forward to the Cassini-Huygens mission. During the thirteen years it spent orbiting Saturn, Cassini sent back stunning images of the moons and rings of Saturn which, while adding extensively to our knowledge of the Saturnian system, also amaze us with their beauty."

Interest group meetings

The **Cosmology** group meets on the first Monday of each month. The next meeting is on **Monday 4 November** at the **Catholic Hall**, starting at **19.00.** The topic is 'Black holes, tides and spacetime – Understanding gravity'

There is an entrance fee of R10 per person for members, R25 per person for non-members, and R10 for children, students and U3A members. For further information on these meetings, or any of the group's activities, please contact Derek Duckitt at derek.duckitt@gmail.com

Astro-photography This group meets on the second Monday of each month. The next meeting will be on **Monday 11 November.** Members will discuss image processing and hardware/software compatibility.

To find out more about the group's activities and the venue for particular meetings, please contact Deon Krige at astronomy.hermanus@gmail.com

Hermanus Youth Robotic Telescope Interest Group Developmental work on this will resume soon.

For further information, please contact Deon Krige at deonk@telkomsa.net

Other activities

Stargazing No event has been scheduled, yet, for November. If arranged, details will be circulated to members.

FUTURE TRIPS

No events are being planned, at present.

2018 MONTHLY MEETINGS

Unless stated otherwise, meetings take place on the **third Monday** of each month at the **Catholic Church Hall**, beginning at **19.00**.

18 November	'The Cassini family dynasty and its Saturnian legacy'. Presenter: Jenny Morris, Centre member
9 December	No meeting

ASTRONOMY SELF-GUIDED EDUCATION CENTRE (ASEC)

Work continues on planning and administrative requirements for work to begin on the proposed Astronomy Self-guided Education Centre, to be located within the existing whale-watching area at Gearing's Point.

The **Friends of the Observatory campaign** was launched several years ago when preliminary work began on plans to construct an astronomical observatory in Hermanus. Over the years, members have been very generous, for which we are deeply grateful. It may seem logical to assume that, now money has been awarded by the National Lotteries Board, pledge monies are no longer needed. Unfortunately, that is not the case. NLC funds can only be used once the plans have been formally approved by the Municipality.

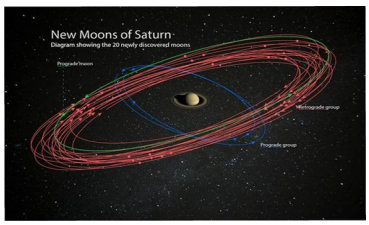
We would, therefore, be very grateful if members could either continue to contribute to the campaign or start becoming a contributor. Both single donations and small, regular monthly donations, of any amount, are welcome. Contributions can take the form of cash (paid at meetings), or online transfer, The Standard Bank details are as follows:

Account name – Hermanus Astronomy Centre
Account number – 185 562 531
Branch code – 051001

If you make an online donation, please include the word 'pledge', and your name, unless you wish to remain anonymous.

ASTRONOMY NEWS\

20 new moons discovered orbiting Saturn 7 October: Astronomers have found 20 new moons orbiting Saturn, bumping its total up to 82 moons. That surpasses Jupiter, which was the prior reigning champion with 79 moons.



An artist's conception of the 20 newly discovered moons orbiting Saturn. NASA/JPL-Caltech/Space Science Institute/Paolo Sartorio/Shutterstock

One of the new moons has the farthest known orbit around Saturn, and all are similar in size, with diameters around 5 km. Two of the moons take about two years to orbit, while the other 18 take more than three years to do so. Seventeen of the new moons orbit Saturn backward - or in retrograde - compared to the planet's other natural satellites. The retrograde moons have orbits resembling some of Saturn's other already-known moons. By looking at their inclinations, astronomers suspect these moons could have been part of a much larger moon that broke apart long ago.

The moons were discovered by a team led by Scott S. Sheppard at the Carnegie Institution for Science and using the Subaru Telescope on Hawaii's Mauna Kea. By studying these small moons and their interactions with our solar system's large planets, astronomers can answer questions about how these worlds were formed and how they've evolved. By: Hailey Rose McLaughlin

How galaxies and their supermassive black holes grow together 7 October: Every massive galaxy likely harbours a supermassive black hole at its centre, weighing in at millions or even billions of times the mass of our Sun. Earlier this year, for the first time ever, a team even managed to image the shadow cast by one of these objects on the hot gas and dust around it. While supermassive black holes are ubiquitous and well studied, the link between these objects and their home galaxies remains mysterious. Now, new research is bolstering a simple idea about how these pairs evolve.


The galaxy UGC 6093 hosts an actively feeding supermassive black hole in its centre. ESA/Hubble & NASA

The authors found that galaxies and their black holes grow together, regardless of where in the universe they are."The observed relation between the mass of the central supermassive black hole the stellar mass of a galaxy has long been a puzzle," Thomas Quinn of the University of Washington said The puzzle's solution has significant implications for how galaxies form and evolve in our universe.

Astronomers already know there is a close relationship between the size of a galaxy and the size of its supermassive black hole, indicating the two somehow know about each other, despite the fact that the supermassive black hole is so much smaller than the galaxy around it.

Some imagine a giant black hole sucking in everything around it until the entire galaxy disappears like water down a drain, but that is impossible. Gravity's influence diminishes

quickly as the distance between two objects increases. So, stars more than a few light-years away from the galaxy's centre are not ruled by the supermassive black hole's presence at all, but instead by the mass of stars, gas, and dust around them. A typical supermassive black hole only accretes, or sucks in, matter from a region just a few light-years across. And its gravity only influences the central 10 light-years or so of the galaxy.

Yet, the mass of a galaxy's spheroid component - its central bulge - and the mass of its supermassive black hole are related. There is also a link between the way stars in a galaxy's bulge move and the mass of its supermassive black hole. What these relationships mean is that somehow, the galaxy at large and its supermassive black hole are connected.

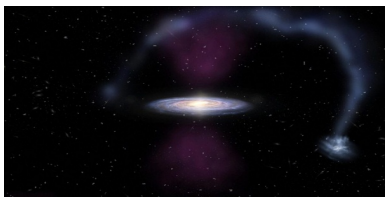
Galaxy evolution happens over billions of years. Astronomers piece the process together by looking at many different galaxies in many different stages of evolution. However, they cannot reconstruct every moment in the complete life of a galaxy and its black hole, but computer simulations *can*s how galaxies and their black holes from start to finish, giving insight into what is happening. In fact, they can show thousands of galaxies, all growing and evolving over time. Quinn and his colleagues used sophisticated code, called ROMULUS, to watch young galaxies evolve, looking at how much the supermassive black hole's activity influenced the amount of star formation in the galaxy, and how the galaxy's growth affected the black hole's feeding habits. Their simulation included thousands of galaxies in various environments, from galaxy clusters to regions where galaxies are few and far between, exactly like the real universe.

Their work gives the clearest picture to date of how black holes and galaxies grow together, and shows that the two appear closely coupled, regardless of many of the factors that might disrupt their symbiosis. "What this study shows is that the supermassive black hole and the stellar population of a galaxy grow together," Quinn said. The team found that no matter how many stars a galaxy was forming, only a small fraction of the gas available to make new stars was gobbled up by the central black hole instead. The fraction of gas consumed by the black hole, he said, stayed the same even in the face of factors the team thought might change it. The black hole had the same amount of food regardless of the number of nearby galaxies, how long the galaxy had to evolve, and even the number of other galaxies it had smashed into in the past. That is interesting because galaxy interactions like flybys that happen in clusters - such as the nearby Virgo Cluster - and mergers such as the famous Antennae Galaxies can affect both star formation and black hole activity in galaxies.

The team also found that, because that fraction of gas available to the black hole stays the same, galaxies and supermassive black holes have a relationship that is 'self-correcting'. If the supermassive black hole starts out too large for its galaxy, a lack of available gas and dust in the galaxy appears to throttle down the black hole's progress so it grows more slowly. Alternatively, if the black hole is small relative to its galaxy, plentiful gas and dust allows the black hole to grow at a faster rate, ultimately catching up to its host. By: Alison Klesman

The Milky Way's supermassive black hole erupted with a violent flare just a few million years ago 10 October: Astronomers believe supermassive black holes probably lurk in the centres of most large galaxies. These gargantuan black holes can gather swirling disks of material around them as their gravity attracts stars and gases. In some cases, these disks can emit vast amounts of light and even shoot huge jets of matter into

space. The centre of such an eventful galaxy is called an active galactic nucleus or AGN. The Milky Way seems to have a relatively calm centre, but astronomers suspect this was not always the case.


A flare erupted from our Milky Way's center some 3.5 million years ago. While Earth wouldn't be in any danger if it happened today, the the light would be clearly visible. James Josephides/ASTRO 3D

Some clues suggest that a flare of energetic radiation burst from our galaxy's centre within the last few million years. In a new study, a team of researchers describes another piece of evidence that the Milky Way burped out such a flare. The research also points to the supermassive black hole in our galaxy's centre, called Sagittarius A* or Sgr A*, as the responsible party. The team also estimated when this event occurred. Their data put the outburst at 3.5 million years ago, give or take a million years. That would mean that the Milky Way's centre transitioned from an active to a quiet phase pretty recently in Earth's history, possibly when early human ancestors were roaming the planet.

The flare would have been visible to the naked eye, shining about 10 times fainter than the Full Moon across a broad spectrum of light wavelengths. "It would look like the cone of light from a movie projector as it passes through a smoky theatre," University of Sydney astrophysicist and lead study author Jonathan Bland-Hawthorn said.

By: Erika K Carlson

Quakes reveal Mars has a unique interior 14 October: NASA's Mars InSight spacecraft landed on the Red Planet in November 2018. Scientists equipped the mission with a seismometer so they could learn how Mars releases seismic energy - that is, to get a feel for how the Red Planet rumbles. So far, InSight has recorded more than 100 seismic signals, and researchers are confident at least 21 of those are real marsquakes. However, these quakes are not exactly what they expected to hear, and the findings have sparked intense curiosity about what lies beneath the dusty surface of Mars.

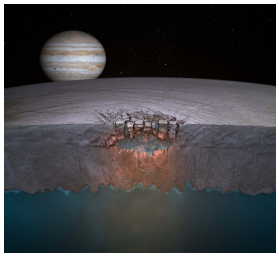
InSight caught its first likely marsquake on 6 April. The tiny quake, which occurred during a lull between a gust of wind and NASA moving the lander's robotic arm, looked a bit like quakes recorded on the Moon in terms of duration and size, b the signal was too small to reveal information about the planet's deep interior.

The way Mars vibrates can tell researchers a lot about what the planet's interior is made of and how it is structured. Prior to InSight, planetary scientists expected rumbling on Mars to look like the earthquakes and moonquakes we see in our home system. However, it turns out that is not the case. "The signatures, the shape of the signals, is not really anything that we're familiar with from either the Earth or the Moon," says InSight Principal Investigator Bruce Banerdt. NASA recently released audio from two such events. The sound of these quakes indicate that Mars' structure may look like a combination of Earth and the Moon. So far, Mars seems to 'ring' longer during a quake, more like the Moon, as opposed to Earth, where quakes appear and disappear much more quickly.

InSight's initial mission will last one Mars year, or about two Earth years. During that time, it will collect plenty of quakes. "We're seeing sort of an average of a couple, maybe a

couple events of some sort per week, lately," says Banerdt. Not all of them will turn out to be real marsquakes, but some are. The seismometer *has* seen about the number of small events - magnitude 3.5 and below on the Richter scale - that scientists were prepared to detect. However, there are few events above that magnitude, which is not what they expected. That expectation, Banerdt says, is based on what's been observed on Earth and the Moon. "We don't know yet whether [the lack of bigger events is] just the statistics, or whether it just means that Mars has a little bit different distribution of the way that it releases its seismic energy than the Earth and the Moon," he says. "Having Mars tell us something a little bit different, it means that there's some aspect of planetary behaviour that has not yet been understood," says Banerdt. "And so that's really an exciting possibility that we're going to learn something fundamentally new about the way planets work in a physical sense." By: Alision Klesman

Jupiter shields Europa from cosmic rays that could erase evidence of life 16 October: Europa, one of Jupiter's four largest moons, has an ocean of liquid water beneath its icy crust. In the coming years, scientists hope to send probes to the world to study the chemistry of its ocean and look for possible signs of alien life. One challenge is figuring out whether radiation hitting Europa would tamper with potential chemical evidence of life. Luckily, it seems scientists will not have to worry too much about this.



Britney Schmidt/Dead Pixel VFX/Univ. of Texas at Austin

Jupiter's presence shields Europa from many of the energetic particles that stream through space, researchers found using a computer model. Though some of these particles, called cosmic rays, will hit Europa, the radiation dosage from them is not significant, the researchers report. This means that chemicals in Europa's ocean, and signs of life they might contain, would be intact for future study.

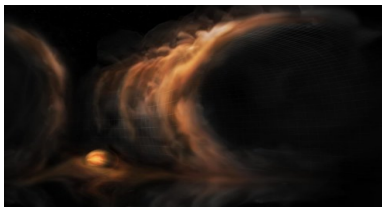
In 2018, planetary scientist Tom Nordheim of NASA's Jet Propulsion Laboratory looked into radiation on Europa from Jupiter itself. He and his team found that energetic particles from Jupiter's magnetosphere, a region marked by the planet's magnetic fields, do not reach more than a few centimetres below Europa's surface. However, the gas giant is not the only source of energetic particles that shower onto the moon. Particles with even higher energies, called galactic cosmic rays, stream through the galaxy from the remains of dying stars.

So, to find out how cosmic rays might affect Europa's ocean chemistry, Nordheim and his collaborators created a computer model. The model simulated how cosmic rays would collide into the atoms on Europa and react, destroying these atoms and releasing further showers of particles. These collisions and reactions continue further into Europa until the particles no longer have enough energy for these reactions. The researchers found that galactic cosmic rays and their resulting particle showers can extend several yards beneath Europa's surface. However, that is not that big of a deal. Jupiter's magnetosphere blocks many of the galactic cosmic rays from Europa, even as the planet showers its moon's

surface with lower-energy particles. That means that, thanks to Jupiter's protection, the galactic cosmic ray dosage that hits Europa is not very significant.

"I think that's pretty exciting in terms of relatively pristine material being right below the surface," Nordheim said. "You don't have to dig incredibly deeply to find material that hasn't been completely modified by radiation." This is one advantage of searching for signs of life on Europa compared to searching on Mars, Nordheim said. Mars does not have a strong magnetic field to protect its surface from energetic particles, so cosmic rays probably heavily affect its surface. Europa, on the other hand, enjoys the protection of our solar system's largest gas giant. By: Erika K Carlson

Gas 'waterfalls' may be feeding atmospheres of young planets 17 October: Stars and their planetary systems are born from clouds of gas and dust that collapse into swirling disks. Astronomers cannot directly see planets forming in these disks because they are hidden in all the debris. In the past few years, new kinds of telescopes have started to reveal gaps in disks around young stars where planets might be forming. Now, astronomers have seen gas flowing in toward the gaps in one of those disks, The finding will help astronomers understand how planets collect the gases that make up their atmospheres. It is also a sign that those gases 'waterfall' down from higher up in the disk - not just the so-called mid-plane where the planets are forming.


Gas 'waterfalls' cascade down onto a forming planet in this artist's illustration. NRAO/AUI/NSF, S. Dagnello

Thanks to a computer model, the team of scientists behind the study showed that planets in those locations can explain the gas motions the researchers saw. With this new piece of evidence, it looks likely that this disk contains at least three planets. As an added bonus, the astronomers discovered that gas motions in these protoplanetary disks are more complicated than expected. "There's a lot more going on than we previously thought," said astronomer Richard Teague, who led the study while at the University of Michigan. "We thought it was just rotating in a rather smooth manner."

When astronomers used the Atacama Large Millimeter/submillimeter Array radio telescope in Chile to snap photos of young stars, they saw clear disks of dust around them. Teague and his team wanted to know what gases in these disks were doing. They looked at ALMA observations of one young star's disk, called HD 163296, in a specific wavelength of light emitted by carbon monoxide gas. Though the gas in the disk is mostly hydrogen, carbon monoxide emits most brightly in the wavelengths the researchers could access and allows for the most detailed observations.

The researchers discovered that gas was not just circling around the star within the disk. They saw gas flowing down into the disk in three concentric rings at different distances from the centre, like water tumbling down both sides of a trench. The three "trenches" they found were 87, 140 and 237 times as far from the young star in the centre as Earth is from the Sun. The two inner trenches were in the same places as gaps seen in the dust of this disk. The outermost one was farther out, where there was not any dust.

The researchers created a computer model of a disk of gas and inserted three planets at the distances where they had seen this new gas flow. Over time, the model evolved to show the same flowing where the simulated planets were - just as the researchers had seen in HD 163296. That means it is fairly likely that planets caused the gas flowing behaviour the researchers saw in the real disk. In the future, Teague said, he plans to study HD 163296 in other wavelengths that will reveal how gas is moving deeper within the disk. He's excited to learn more about the detailed motions of gases in a newly forming planetary system. By: Erika K Carlson

Hubble reveals that galaxies without dark matter really exist 18 October: Astronomers have all but confirmed the universe has at least one galaxy that is woefully deficient in dark matter. The new finding not only indicates that galaxies really can exist without dark matter, but also raises fundamental questions about how such oddball galaxies form in the first place.


This new and incredibly deep image from Hubble shows the dim and diffuse galaxy NGC 1052-DF4. NASA/ESA/STScI/S. Danieli et al.

The researchers used Hubble's keen eye to take new, deep images of the ghostly galaxy NGC 1052-DF4 (or DF4 for short). Equipped with fresh observations, they identified the bizarre galaxy's brightest red giant stars (called the Tip of the Red Giant Branch, or TRGB). Because TRGB stars all shine with the same true brightness when viewed in infrared, the only thing that should affect how bright they appear is their distance. By identifying the galaxy's TRGB and using that to determine DF4's distance, the new data essentially confirms the galaxy is located some 61 million light-years away. According to the researchers, this essentially debunks other studies that claim DF4 is much closer and therefore contains a normal amount of dark matter."I think this is definitive," co-author Pieter van Dokkum of Yale University. "The TRGB cannot be argued with: it is caused by well-understood stellar physics, and [is] as direct as distance indicators get."

However, astronomer Ignacio Trujillo of the Instituto de Astrofisica de Canarias is sceptical of van Dokkum's conclusion. "They need to show that their analysis is not biased to produce a large distance first," he said. "I think there are a number of choices the authors have used that have not been justified. All of these choices seem to be selected to favor a larger distance than what the data suggests."

Over the last few years, there has been a controversy brewing in the astronomical community. In 2018, van Dokkum and his team stumbled upon a ghostly galaxy, nicknamed DF2, that seemed to lack any significant amount of dark matter. Because dark matter is thought to account for about 85 percent of all matter in the universe, the apparent discovery of the first galaxy without the elusive substance raised a lot of eyebrows. Trujillo is one such sceptic. Intrigued by the extraordinary claim of a galaxy without dark matter, Trujillo and his team quickly carried out their own analysis of DF2. Based on a variety of methods, Trujillo's team determined that DF2 was actually much closer than van Dokkum's team claimed - some 42 million light-years away rather than 61 million light-years. This, Trujillo argued meant that DF2 was not as strange as initially

thought, and instead hides about as much dark matter as you would expect from your average, run-of-the-mill galaxy.

Then, just six days later, van Dokkum's team published yet another study identifying a second galaxy, named DF4, that was located about the same distance away as DF2 and likewise lacked dark matter. Yet again, Trujillo and his colleagues went about calculating their own distance to DF4. Based on the Hubble data available at the time, the Trujillo's camp identified what, they thought, was DF4's TRGB. However, according to the newly presented Hubble data - which picked up many more, much fainters stars - Trujillo's team may have misidentified the TRGB. "In the new data, there really is no ambiguity," says study autho Shany Danieli of Yale University. "We think the new data really rule out the [closer distance derived by Trujillo's group]. The TRGB is generally seen as definitive, as its physics is well understood."

If these latest results hold up to the scrutiny that is likely to come, then discovering the first (and possibly second) galaxy without dark matter would fundamentally change our understanding of how we think galaxies form and evolve. "[DF4 and DF2] point to an alternative channel for building galaxies - and they even raise the question whether we understand what a galaxy is," van Dokkum says. Right now, he says, we think that galaxies begin with dark matter, which is how they are able to gravitationally attract the massive amounts of gas and dust needed to kick-start star formation. "The thing is, we have no idea how star formation would proceed in the absence of dark matter," van Dokkum says. "All we can say is that there must have been very dense gas early on in their history," otherwise, the galaxies couldn't create new stars.

Is this latest distance determination to DF4 really robust enough to start exploring the implications of finding a galaxy without dark matter?"Yes, that's our hope. We'd love to move to discuss what these galaxies mean, rather than whether our measurements were correct," Danieli says. By: Jake Parks

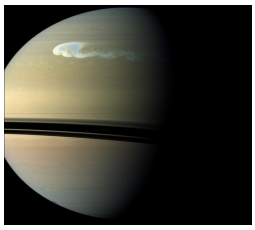
United Kingdom engineers are sending this weird spider bot to the Moon 21 October: The United Kingdom is sending a small, four-legged robot to the Moon in 2021. The tiny rover, which looks like a cross between a spider and a children's toy, will be the first Moon rover for the UK. It will also be the first rover with legs to walk on the Moon.

The tiny rover only weighs a little over two pounds. Spacebit

Created by the private UK-based company, Spacebit, the tiny rover will fly on a United Launch Alliance Vulcan rocket, and be launched from Cape Canaveral in Florida. The rover will hitch a ride inside the Peregrine lander, created by US company, Astrobotic. The lander will bring the small robot to our orbiting neighbour before releasing it off for its 10-day mission.The tiny rover can jump and only weights a little over one kilogram. While on the Moon, the rover will travel 10 meters from the lander, sending back full HD videos.This could be the beginning for Spacebit and the tiny spider-like rover. If the mission goes as planned, more small rovers could be sent to the Moon to explore lava tubes, which scientists think may be a suitable environment for humans to live in one day.

If the rover can successfully reach the Moon, it will mark the UK as the fourth country to land a rover on our satellite, behind the United States, Russia, and China. With Peregrine as well, it will also be the first soft lander from the US to reach the Moon since the Apollo era. By; Hailey Ros McLaughlin

A new kind of storm appears on Saturn, puzzling astronomers 23 October: As serene as it appears in photographs, the gas giant Saturn is not a peaceful place. Its golden gases whiz around the planet at up to a thousand miles per hour. At times, massive storms thousands of miles wide break out in its upper atmosphere. In 2018, astronomers spotted a new kind of storm on Saturn. Four large tempests formed one after another, passing by each other and further disturbing the atmosphere to create a complex storm system that lasted months.


A large storm on Saturn, commonly referred to as a Great White Spot. NASA/JPL-Caltech/SSI

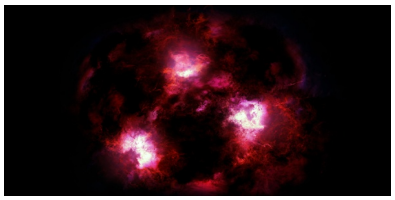
Computer models let the researchers estimate the energy behind the event and compare it to other storms on Saturn. Studying these phenomena in more detail may let astronomers better understand the complex behaviours of the giant planet's atmosphere. The researchers from Spain, Australia the US and France first noticed the new storms in photographs that amateur astronomers had taken and uploaded to a public online repository. They spotted the first of the four storms in March 2018, visible as a distinct white spot near Saturn's north pole. The following three storms popped up in the months after. With several months of follow-up study, the researchers realized that this series of storms was different from those seen before. "This is a new type of storm that is telling us something about the unknown formation mechanisms," of these storms, said Enrique García-Melendo, an astronomer at Universitat Politècnica de Catalunya. The way these storms form likely depends on not-fully-understood interactions between water vapour, seasonal differences in exposure to sunlight and the complicated, multi-layered atmosphere.

Saturn's storms tend to come in two main sizes. The smaller storms are usually a little more than a thousand miles across and last several days. The larger type, called Great White Spots, are gargantuan storms ten times as large. Astronomers have only seen seven of them since 1876. For some reason, these Great White Spots tend to appear somewhere in Saturn's northern hemisphere about every 30 Earth years. This is equivalent to once each Saturn year, usually during the same season or time of year on the gas giant. The new series of four intermediate-sized storms appeared in 2018, at about the right time to fit into this cycle.

Astronomers do not yet understand how this repeating cycle of storms may be related to seasons on Saturn. It may be linked to how the atmosphere heats and cools as it receives different amounts of sunlight, the researchers said. The complicated behavior of water vapor responding to changes in temperature and pressure could play a role as well. The researchers hope that future observations with the James Webb Space Telescope and with

larger Earth-bound telescopes will let them learn more about these storms and one day solve the mystery. By: Erika K Carlson

This monster galaxy made stars hundreds of times faster than the Milky Way
25 October: Our universe's history began about 13.8 billion years ago with the Big Bang. When astronomers probe deep into space, they see parts of the universe as they were early in this history. That is because it takes light a long time to travel vast distances. To find out how galaxies formed and evolved over time, astronomers look for the oldest, most distant objects they can see.These observations reveal that massive galaxies appeared in the universe as early as 1 billion or 2 billion years after the Big Bang. How were there already enough stars to make such large galaxies? The findings imply that early massive galaxies must have formed stars at incredibly high rates.


An artist's rendering shows an early galaxy surrounded by gas and forming new stars at a tremendous rate. James Josephides/Christina Williams/Ivo Labbe

A team of astronomers has now spotted one of these early galaxies in the act of churning out stars. Their observations capture the galaxy, which is about the size of the Milky Way, as it was about 1 billion years after the Big Bang. However, the galaxy is creating roughly 300 Suns' worth of stars per year, while the Milky Way forms just one or two solar masses of stars each year. The team says their find is something of a 'cosmic yeti' because astronomers previously dismissed the idea that such monster early galaxies ever existed.

Christina Williams, an astronomer at the University of Arizona, was using the Atacama Large Millimeter/submillimeter Array to study another galaxy when she noticed an unexpected little blob in her images. When she and her team investigated further, they realised the blob was an extremely distant galaxy more than 12 billion light-years away. The researchers looked at other images of this patch of sky and discovered faint traces of the galaxy in various wavelengths of light. Those traces by themselves were too faint for anyone to be sure there was a galaxy there. However, combined with the much clearer and brighter ALMA data, the researchers could be more confident that those traces of light came from the same galaxy. From the traces of light the researchers gathered, they were able to infer how fast the galaxy is building up its store of stars.

Because the researchers stumbled upon the galaxy by accident in a fairly small patch of sky, they believe these quickly star-forming galaxies are not rare."The fact that we've been able to find one object and that it's relatively common - that makes me excited for future surveys," Williams said. "Hopefully, we will find more, and then we'll be able to measure the formation histories of these things better with future data."

By: Erika K Carlson

Source of these and further astronomy news items: www.astronomy.com/news

DID YOU KNOW?

Astronomical catalogues Part 13: Bennett and Caldwell catalogues – Messier catalogue descendants

Although catalogues began increasingly to be produced by large groups and organisations, the historic trend of publication of catalogues by individuals has continued. Two such catalogues are descendants of Messier's initial 1771 catalogue.

Bennett Catalogue

John (Jack) Bennett (1914 – 1990) was an amateur South African astronomer A committed comet-hunter, from his back garden he observed, for decades, from the early 1960s onwards. He discovered 2 comets: Bennett's comet, in 1969, and another one in 1974. He was also the first person to visually discover a supernova in another galaxy since the invention of telescopes. Bennett's achievements were recognised by an honorary MSc in 1966 and receipt of the ASSA's Gill Medal in 1970.

Apart from comets, like Messier, Bennett also observed deep-sky objects resembling comets. In 1969, he published a list of 130 deep sky objects South of the celestial equator. An additional 22 objects were included in his 1974 supplementary list. Later, his lists were combined to form the *Bennett Catalogue.* It is the southern hemisphere Messier-type list of comet-like deep sky objects.

It Includes objects which are not notably comet-like, but were included as they may appear so in poor conditions. The 152 objects include the Tarantula nebula, Omega Centauri and 47 Tucana. Constellations rich in so-called Bennett objects are Scorpio, followed by Ophiucius then Sagittarius. Almost half the objects in these constellations are globular clusters which, except for the largest, easily resemble tailless comets. Dorado also has many Bennett objects – 5 galaxies, 6 clusters and nebulae, the latter in the LMC The catalogue includes 26 Messier objects. Bennett numbers are listed as eg Ben 2, Ben 114.

Caldwell Catalogue

This, more recent catalogue, was published in 1995. Compiled by the well-known British amateur astronomer Patrick Moore (1923 - 2012), it was aimed at amateur astronomers. The *Messier Catalogue* is often used as a list of deep sky objects, although it was not compiled for this purpose. It focusses only on those objects which could be mistaken for a comet and does not include many of the brightest deep sky objects eg Hyades. Also, Messier did not include southern hemisphere objects eg Omega Centauri. Moore addressed these issues.

His list includes 109 objects, the same number as Messier's catalogue (M110 was excluded, as its place is debated). He used his other surname – Caldwell – to name the list, as the first letter of Moore is already used for Messier objects eg M42. Catalogue entries are designated C followed by numbers 1-109. In the Messier catalogue, objects were listed roughly in order of their discovery. In contrast, Moore ordered the *Caldwell Catalogue* in order of declination. C1 is the most northerly, and C109 the most southerly, although 2 are listed out of sequence ie Hyades and NGC 4244. Errors in the original list have been corrected in later editions.

The *Caldwell Catalogue* includes the following objects: dark nebula (1), galaxies (35), globular clusters (18), bright nebulae (9), star clusters (25), star clusters and nebulae (6), planetary nebulae (13) and supernova remnants (2). So-called Caldwell objects include:

Cat's eye nebula (C6), Hyades (cluster C41), Centaurus A (C77), Omega Centauri (C80), Eta Carinae nebula (C92), Jewel Box cluster (C94), Coalsack nebula (C99) and 47 Tucanae (C106).

Sources: Ridpath, I (Ed) (2012) Oxford dictionary of astronomy 2nd ed rev, www.assa.ac.za, www.en.wikipedia.org

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